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Protection Branch Report of Test No. 2-61

EFFECT OF GAMMA AND X-RAYS UPON DRY BACTERIAL SPORES

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This investigation was undertaken to determine if low dosage X-rays and gamma rays had a significant lethal effect on bacterial spores and if so could this procedure be utilized to sterilize the interior of the Allegany Ballistics Laboratory's (ABL) X-248A5D motor if it were lightly contaminated. The reason for considering ways of sterilizing such a motor was that a scheduled lunar probe was so designed that the third stage X-248A5D motor would follow the path of the payload in outer space. Since it is now the policy to decontaminate all objects which will contact or even approach an extraterrestrial planet, the payload of the lunar probe in question and the third stage motor as well would require sterilization.

Temperature measurements, made by ABL personnel, of the motor during firing, revealed that a small area in the neck region did not become hot enough to be heat sterilized. Thus some other means must be employed to sterilize the motor.

Heat could not be used since the motor could not be heated enough to sterilize and yet not damage the motor. An investigation conducted at ABL by Hercules Powder Company* revealed that ethylene oxide gas has

* Hercules Powder Company, Allegany Ballistics Laboratory, Inter Office Memoranda from R.D. Blair to W.E. Kight, Subject (1) Exposure of X248 Inert Parts to Sterilizing Gases, dated 23 Sept 1959, and (2) Exposure of X-248 Inert Components to Sterilizing Atmospheres, dated 6 Nov 1959

no obvious deleterious effect on the components of the motor and thus the gas can be used to sterilize the motor exterior. However ethylene oxide gas would not penetrate and sterilize the interior of a non-porous object like the X248A5D motor.

One quite simple method of sterilizing the motor has been suggested. This suggestion involves painting the exterior of the motor with black paint thus giving a highly efficient heat adsorbing surface when in the direct rays of the sun. The fairing of the missile would cover and protect the motor from heating up until a short time before the motor fires. After this the black surface would absorb heat from the sun and thus raise the temperature within the spent motor. Preliminary calculations at Goddard Space Flight Center indicate that sufficient heat would be generated in outer space to sterilize the interior of the spent motor before the motor could possibly contact the moon.

Another suggested technique of sterilizing the interior of the motor was by radiation. The motor is X-rayed by means of a Betatron which produces extremely penetrating radiation, after the motor is filled with solid propellant, to assure that no bubbles or voids are present in the fill. It was suggested that this operation might have a sterilization effect. However, it was revealed that the intensity and hence the total X-ray dosage to which the motor is subjected in any reasonable length of time is low compared to that which investigators have found necessary (2 to 4 million roentgens) to sterilize heavily contaminated articles and liquids.

It was still thought advisable to check the decontaminating effect of this high energy, low dosage radiation, and this is the main subject of this report. Besides the Betatron, a low radiation Cobalt 60 source which emits gamma rays was also available for experimentation.

In order to evaluate the antimicrobial effects of low dosage X-rays and gamma rays, dry bacterial spores deposited on cloth patches were irradiated at the Allegany Ballistics Laboratory, Cumberland, Md. and returned to Fort Detrick for assay.

MATERIALS AND METHODS

An aliquot of a Bacillus subtilis var niger spore suspension was put on each herringbone twill patch (1.5 centimeters in diameter) and allowed to air dry before it was put into a paper packet. The packets were subjected to varying amounts of radiation (see Table I for the specific conditions). Radiation for these tests was supplied by the Betatron operating at a 22 MEV peak and the Cobalt 60 operating at approximately 1.3 MEV. After exposure to radiation, a bacteriological assay of each patch sample was made. Each patch was removed from its packet with sterile forceps and placed in a tube of 0.01 per cent Tween 20 diluent and shaken. Aliquots of the samples and the subsequent serial distilled water dilutions were plated by the pour plate method and cultured in tryptose agar. The plates were incubated at 37C for 48 hours before colony counts were made.

RESULTS

The results given in Table I show that radiation in the dosage given has no effect upon dry spores of B. subtilis var niger. It is apparent that from the results of this test, unless the radiation dosage is increased considerably, this technique can not be relied upon to sterilize the ABL X248A5D motor.

Table I.

Effect of Low Dosage Radiation Upon Dry B. subtilis var niger Spores

Dosage* (Roentgens)	Radiation Source	Source to Sample Distance	No. Bacteria Recovered per patch**
270	Cobalt 60	10 cm.	85,000
495	Cobalt 60	10 cm.	107,000
990	Betatron	1 foot	70,000
1,980	Betatron	1 foot	96,000
4,950	Betatron	1 foot	110,000
12,150	Betatron	1 foot	114,000
27,000	Betatron	1 foot	95,000
12,650	Cobalt 60	2 cm.	110,000
6,900	Cobalt 60	2 cm.	119,000
None	None	-	104,000
None	None	-	109,000

* The calculated dosage contributed by the radiation source with no allowance being made for scattered radiation

** Based upon the average of two or three samples radiated at the same time